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Expeditionary Warfare Communications Enhancement Program

Fiscal Year 1998 Test Report

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ADMINISTRATIVE INFORMATION

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1.0 INTRODUCTION

1.1 PURPOSE

This report documents the results of the Fiscal Year (FY) 1998 Expeditionary Warfare Communications Enhancement (EXCOM) Program test effort, which involved laboratory testing at SSC San Diego and operational testing performed onboard USS *Nassau* Amphibious Ready Group (ARG). Figure 1-1 depicts the composition of USS *Nassau* ARG and II Marine Expeditionary Force (MEF) forward (FWD).

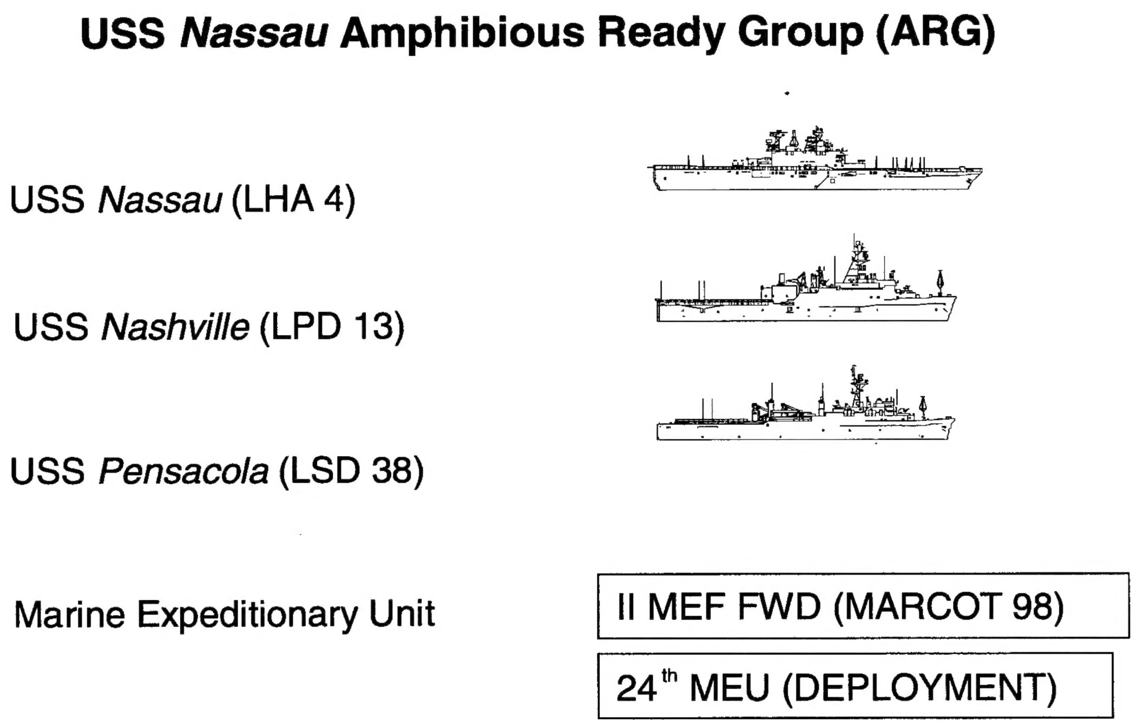

Figure 1-1. USS *Nassau* ARG ship composition.

Results of both testing efforts are reported below, with emphasis on results obtained during the Maritime Combined Operations Test (MARCOT)/Unified Spirit 98 NATO Joint Combined Forces Exercise conducted during 8–18 June 1998.

a. These tests are part of the third effort in a series of demonstrations aimed at identifying systems with the potential to improve information flow from ship-to-ship and ship-to-objective area. The tests were conducted in compliance with the requirements of the EXCOM Enhanced Position Location Reporting System (EPLRS) Test Plan, the EXCOM Advanced Capabilities Demonstration Program, and the EXCOM FY 1998 Project Plan.

b. Operational tests were conducted during MARCOT/Unified Spirit 98 to confirm both the operational concepts and the readiness of EXCOM equipment installations onboard USS

Nassau ARG. These tests were designed to validate the EXCOM systems architectures defined for use by the USS *Nassau* ARG and the 24th Marine Expeditionary Unit (MEU) during their 1998 deployment.

1.2 BACKGROUND

Navy and Marine forces can fulfill their forward presence role most effectively when they can limit required external support from bases, ports, and airfields. Operational Maneuver From the Sea (OMFTS) describes rapid maneuvering by landing forces from their transport ships directly to objectives ashore, uninterrupted by topography or hydrography. Rapid maneuvering reduces the vulnerability of the maneuver force. Capabilities available to the landing force during the early stages of modern amphibious warfare development dictate that the Amphibious Task Force (ATF) provides both the means of landing force movement and its control. Emerging technologies should provide landing force units with the required mobility and information flow to support OMFTS. New capabilities should enable tactical commanders to make decisions as the situation develops, to exploit enemy weaknesses, and to maintain the momentum of the attack throughout all maneuvers. The combination of maneuver warfare philosophy and selected emerging technologies will provide Navy and Marine forces with enhanced combat effectiveness. When executing ship-to-objective maneuver (STOM), landing forces should exploit technological advances; this will permit combined arms maneuver from attack positions through and across the water, air, and land of the littoral battlespace directly to inland objectives.

1.3 PROGRAM GOALS

The EXCOM Program's primary aims are to identify, combine, and demonstrate the effectiveness of Government Off-the-Shelf (GOTS), Commercial Off-the-Shelf (COTS), and Non-Developmental Item (NDI) products as mechanisms for exploiting technological advances on behalf of the Navy/Marine Corps team. This, in turn, provides a foundation from which to inject successful system candidates directly into the Fleet.

1.4 PROGRAM OBJECTIVES

Landing forces conduct STOM by executing detailed yet flexible plans. At any point during the maneuver phase, the on-scene tactical commanders may choose to vary their attack formations or other instructions to the landing force, based upon the changing situation. This program seeks to identify and validate network integration enhancements that provide improved data interoperability and information exchange among Navy, Marine Corps, and Joint elements to meet the challenge of this fluid environment. Technical enhancements have the potential to improve the landing force commander's ability to see and influence the battlefield, while extending information to subordinate commanders will allow them to identify and exploit opportunities as they arise.

The FY 1998 program objectives focus on ship-to-ship and ship-to-objective connectivity to provide the tactical data required for commanders to recognize appropriate actions and to communicate their decisions to ensure mission accomplishment. The emphasis is to:

a. Provide the connectivity required for landing force commanders to see a Common Operational Picture (COP), monitor task execution, and influence events, as necessary.

b. Validate ARG and MEU tactical operational requirements for ship-to-ship and ship-to-objective communications in support of the amphibious assault and subsequent maneuvers.

c. Evaluate and implement multi-discipline technical and management capabilities to provide improvements across the spectrum of expeditionary and littoral warfare communications.

d. Provide the communications bandwidth and connectivity required for near real-time data transfer and event-triggered tactical decision aids, which encompass the following capability enhancements:

   1. Multi-media conferencing for Amphibious Operations Area (AOA) collaborative warfare planning and execution.

   2. Data networking of individual radios and systems within the littoral environment.

   3. Data-flow improvement for dissemination of information supporting the Common Tactical Picture (CTP), battle damage assessment, and measure of effectiveness to the warfighter.

   4. Surveillance data exchange and threat warning.

   5. Data networking in support of mobile applications on the battlefield.

   6. Transformation of data into actionable knowledge by improving information sharing.

The technologies demonstrated in support of these objectives are:

a. Integration of ship-to-ship and ship-to-objective area low and medium data rate (LDR/MDR) network and radio link technologies such as the following:

   1. Position Location Reporting System (PLRS)

   2. Enhanced Position Location Reporting System (EPLRS)

   3. AN/KSQ-1 Amphibious Assault Direction System

b. Use of the Automated Digital Networking System (ADNS) for seamless Transfer Control Protocol/Internet Protocol (TCP/IP) data networking connectivity.

c. Collaborative staff planning and management tools that employ dynamic use of available radio and network resources (equipment and spectrum).

d. Scaleable versions of these capabilities suitable for ships and craft employed in the littoral regions during ship-to-objective area movements.

1.5 PROGRAM APPROACH

The program emphasizes empirical research to select candidate COTS and GOTS communications and network technologies and under-utilized fielded systems for use in enhancing the communications infrastructure of expeditionary forces. Applying integration management techniques reduces risk and costs for the demonstration and validation of network and CTP architectures expected to occur during expeditionary or littoral warfare operations.

The selected technical approach is a blend of experiments and demonstrations, followed by extended collaborative evaluation through user testing conducted in conjunction with ARG and MEU deployments (typically 6-month force deployments). The approach included a sequence of laboratory tests and evaluations and collaborative fleet evaluations covering the ARG and MEU work-up periods prior to deployment. The laboratory testing and work-up exercise demonstration periods allowed for test data collection and test management in as controlled an environment

possible. Informal operational data collection is expected to continue during the actual ARG and MEU deployment.

Tests were designed to provide qualitative and quantitative measures of the improvement of new technology over existing capabilities, and to attempt to match available technology with functional requirement shortfalls identified by the ARG and MEU teams. Additionally, these tests assist in identifying cost-effective migration strategies for seamless integration of state-of-the-art video, voice, and data technologies to support the OMFTS and STOM operational concepts.

1.6 PREVIOUS EFFORTS

The EXCOM Program has focused on enhancing intra-ARG communications links that support mission requirements for ATF elements as they transition between the ship-to-ship and ship-to-objective area environments. The operational concepts of OMFTS and STOM are essential backdrops and capability drivers. There have been two prior demonstrations, as described below.

1.6.1 FY 1996 Effort

The first stage of this project was conducted onboard USS *Essex* ARG during its FY 1996 deployment. This demonstration evaluated intra-ARG TCP/IP connectivity using an Ultra High Frequency (UHF), Line-of-Sight (LOS), wideband, MDR, Time-Division Multiple Access (TDMA) network exchange system centering on a Hazeltine secure packet radio suite. This system provided ship-to-ship TCP/IP data connectivity as well as collaborative planning and desktop Internet Protocol (IP) video teleconferencing.

1.6.2 FY 1997 Effort

The subsequent effort focused on USS *Boxer* ARG during its FY 1997 deployment and consisted of three primary demonstration elements:

a. The first element evaluated the application of asymmetrical, wideband, broadcast UHF radio links with an existing narrowband UHF radio voice channel for voice response links. This UHF LOS broadcast system used modified AN/WSC-3/V6 radios to support simplex video broadcasts up to 576 Kbps among the ARG ships.

b. The second test element evaluated was the Joint Internet Controller (JINC). The JINC provided the ability to simultaneously control multiple radio paths for data transfers, in this case, via standard shipboard High Frequency (HF) and Very High Frequency (VHF) Single-Channel Ground/Air Radio System (SINCGARS) radios. The demonstrated application showed the ability to pass data between the Joint Maritime Command Information System (JMCIS) and the Tactical Combat Operations System (TCO).

c. The third demonstration element evaluated the effectiveness of using HF Automatic Link Establishment (ALE) radio systems with the Battle Force Electronic Mail (BFEM) System to transfer TCP/IP electronic mail (e-mail) messages from ship-to-shore. HF ALE-capable radios were provided for Marine forces ashore while the HF radio system on USS *Boxer* was upgraded to support ALE. This element provided ship-to-shore e-mail message and file transfers over HF channels using ALE protocols and techniques.

d. The fourth demonstration element used the AN/MRC-142 Radio Terminal Set both afloat and ashore. The AN/MRC-142 was installed onboard USS *Boxer* to provide full-duplex (FDX) UHF LOS radio-trunking capability for ship-to-shore voice communications. The system installations included an external 200-watt power amplifier for the shipboard and shore systems, and an omni-directional antenna for the shipboard installation.

1.7 FY 1998 EFFORT

This section covers FY 1998 laboratory testing as well as the demonstrations undertaken during MARCOT/Unified Spirit 98. The MARCOT evaluation incorporated improved approaches to link capacity using TCP/IP network connectivity techniques, applied dynamic resource allocation between new and existing systems, and an integrated joint network management and control capability under the ADNS architecture. The effort focused on the following tasks:

a. Demonstrate shipboard integration and operation of high-capacity radio frequency (RF) links between ships at sea and from a ship to an objective area through the integration and installation of the EPLRS, PLRS, and KSQ-1 systems.

b. Concentrate on making use of previously overlooked or under-utilized frequency spectra and equipment combinations.

c. Continue to use proven approaches to link capacity improvement using network connectivity techniques developed from FY 1996 and FY 1997 demonstrations.

d. Continue to apply dynamic resource allocation between new and existing systems. Pursue integrated joint network management and control capability under the Joint Maritime Communications System (JMCOMS) ADNS architecture.

e. Use collaborative staff planning and management tools that employ available radio resources.

2.0 EXPEDITIONARY WARFARE ARCHITECTURE AND CONFIGURATIONS

2.1 DEMONSTRATION COMPONENT DESCRIPTION

The components of the systems integration effort demonstrated during the laboratory and field component tests are described in the following sections.

2.1.1 PLRS

PLRS provides basic tactical functions of position, location, navigation, unit identification, and limited data communications. PLRS consists of a Master Station (MS) and User Units (UU) that can be transported by manpack, vehicle, and aircraft. The MS is the hub of the system and receives all PLRS data. The system is based on a secure, jam-resistant UHF radio. Each UU automatically transmits a self-identifying signal burst on a precise schedule, receives signals from other UUs, and automatically relays them to the MS or from the MS to another UU. The User Readout (URO) permits the operator to receive and display information transmitted from the MS. PLRS has been selected by the Navy for the control and identification of vessels as part of the AN/KSQ-1 program.

2.1.2 EPLRS

EPLRS is an integrated Command, Control, and Communications (C3) system which provides near real-time data communications, position, location/navigation, identification, and reporting information. EPLRS provides position and navigation data distribution both vertically and horizontally. EPLRS supports highly mobile automated data exchange using TDMA access and frequency-hopping technology.

EPLRS was considered as a test candidate for the EXCOM FY 1998 effort because of its inherent FDX networking capabilities. This was viewed as an opportunity to use an existing military asset in support of TCP/IP, collaborative planning, and data exchange requirements for ship-to-ship and ship-to-objective area applications. The EPLRS demonstration evaluated FDX LOS and beyond LOS radio links supporting TCP/IP data transfers at rates in the range of 3.6 to 28.8 Kbps FDX. Under this task, EPLRS linked multi-system architectures using a robust, automatic relaying and automatic re-routing communications network that provided rapid, jam-resistant, and secure data transfer between component systems.

2.1.3 AN/KSQ-1 Amphibious Assault Direction System

The AN/KSQ-1 Amphibious Assault Direction System (AADS) integrates the Marine Corps PLRS with the Global Positioning System (GPS) and interfaces PLRS with JMCIS so that AN/KSQ-1 equipped units can be tracked on the COP during amphibious assault operations.

The AN/KSQ-1, in conjunction with PLRS/EPLRS, provides Position Location Information (PLI), communications, and craft waypoint loading capabilities for the ARG during assault operations. AN/KSQ-1 equipment suites are being installed on designated Amphibious Command Ships (ACS), Primary Control Ships (PCS), Secondary Control Ships (SCS), and other amphibious ships and landing craft. AN/KSQ-1 provides accurate, real-time information to the ACS, PCS, and SCS on the

position and movement of naval surface landing craft and ships in the ATF. Figure 2-1 shows a component drawing of an AN/KSQ-1 deployment. The AN/KSQ-1 workstation—known as an Amphibious Command Workstation (ACWS), Primary Control Workstation (PCWS), or Secondary Control Workstation (SCWS), depending on the host ship—is a Tactical Advanced Computer (TAC) workstation running JMCIS software. AN/KSQ-1 software is JMCIS-compliant, adding an AN/KSQ-1 pull-down menu to the JMCIS system menu bar where all AN/KSQ-1 functions can be accessed.

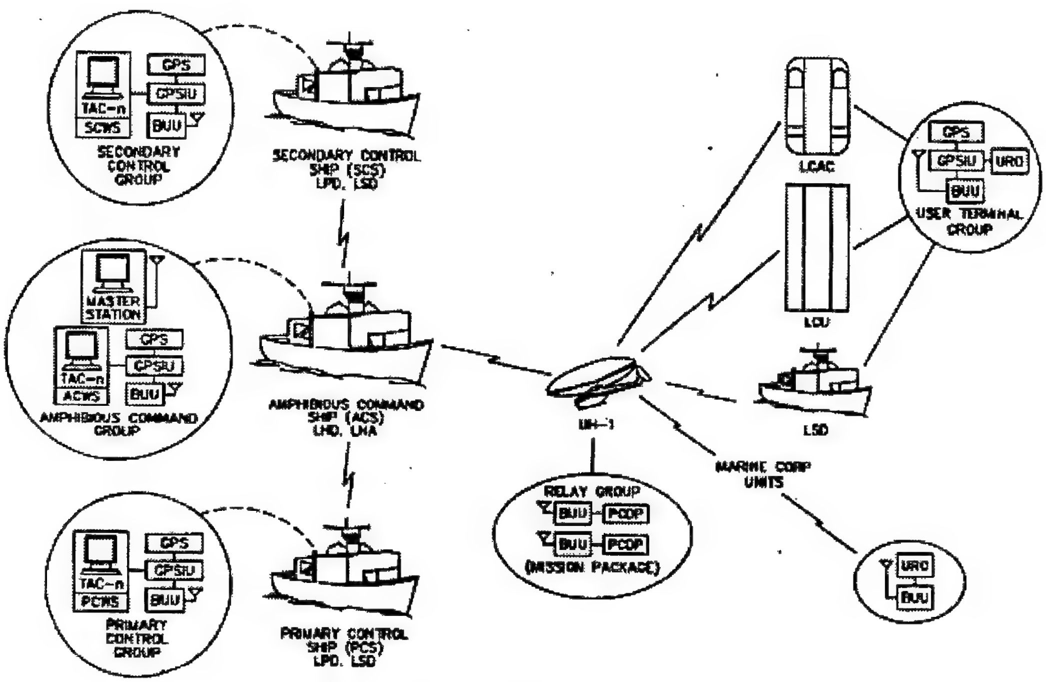

Figure 2-1. AN/KSQ-1 deployment.

A typical amphibious assault scenario would normally involve a PCS, an ACS, an SCS, a number of landing craft, and forces deployed in a ship-to-objective area movement of amphibious forces. When the scenario dictates an over-the-horizon (OTH) amphibious operation, an airborne relay is required to maintain the PLRS network beyond LOS distances. Figure 2-2 shows the AN/KSQ-1 Operational Scenario.

PAGES 9 & 10

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a. EPLRS applicable modes of operation.

b. EPLRS HDR needline configuration and evaluation.

c. TCP/IP router setup and protocol configuration.

d. EPLRS TCP/IP network performance and loading.

e. Interface requirements to ADNS.

f. Network Control Station (NCS) and the EPLRS Rapid Network Initialization System (ERNIST) EPLRS network control.

During this period, it was discovered that the EPLRS point-to-point mode of operation was the best-suited for supporting a TCP/IP network. Specific X.25 protocol configuration details were identified and modified to optimize router-to-router connections which, in turn, improved data throughput. X.25 is an international standard that has been widely adopted for packet-switched networks. X.25 defines interface requirements between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE). The DTE generally refers to the router or host equipment side of the interface and the DCE refers to the communications network side.

Additionally, this information identified the requirement for the Open Shortest Path First (OSPF) routing protocol in support of ADNS interfacing. The NCS and the ERNIST systems were used to create needline libraries, which were used to identify the best combination of data rates to support a TCP/IP network for an ARG deployment.

2.2.2 MARCOT Operational Test

The second testing period was conducted during the MARCOT exercise and provided an opportunity to demonstrate PLRS, EPLRS, and AN/KSQ-1 network technologies in a realistic operational environment. The main objectives were to demonstrate consistent TCP/IP data communication connectivity with accurate PLI acquisition and dissemination.

Afloat operations were controlled primarily from USS *Nassau* (LHA-4), on which the PLRS, EPLRS, NCS, AN/KSQ-1, and two transportable systems (User Terminal Groups (UTGs)) were located. PLRS, EPLRS, and AN/KSQ-1 equipment was also installed onboard USS *Nashville* (LPD 13). USS *Nashville* installation included the EPLRS ERNIST computer control system. ERNIST allows EPLRS needline establishment and control for data networking connectivity, but does not support PLI dissemination. ERNIST was installed to support split-ARG operations during deployment if USS *Nassau* had to move beyond LOS from the other two ships for any extended period. USS *Gunston Hall* (LSD 44) had an AN/KSQ-1 system installed and participated in the MARCOT exercise.

USS *Pensacola* was the third ship of USS *Nassau* ARG but did not receive the EPLRS and AN/KSQ-1 installations until after the MARCOT exercise.

Operations ashore were conducted from the two portable systems. Each system was equipped with an EPLRS radio, a Cisco 2514 TCP/IP router, a GPS Interface Unit (GPSIU), and an IBM-compatible laptop computer loaded with Windows for Workgroups and the BFEM server and client software. Table 2-1 describes equipment configurations installed onboard the ships and the units ashore.

Table 2-1. MARCOT/USS *Nassau* ARG PLRS/EPLRS and AN/KSQ-1 configuration.

SHIP INSTALLATIONS

USS *NASSAU*

NCS conposed of

- TAC-4 Workstation
- RT-1572/TSQ-158 ECRU
- AS-4454/KSQ-1 Antenna
- KOK-13/TSEC Remote Rekey Equipment
- Printer

AN/KSQ-1 composed of:

- TAC-4 Workstation
- RT-1572/TSQ-158 BUU
- AS-4454/KSQ-1 (V) Antenna
- J-6904/KSQ-1 GPS Interface Unit (GPSIU)
- Printer

UTG composed of:

- IBM-Compatible Laptop Computer
- CISCO Router
- TR-1720/TSQ-158 EPUU
- AS-4545/KSQ-1 Antenna

USS *GUNSTON HALL*

- TR-1343/TSQ-129 BUU
- AS-4454/KSQ-1 Antenna

SHORE INSTALLATIONS

MARINE 1 and MARINE 2

Portable UTG composed of:

- IBM-Compatible Laptop Computer
- CISCO ROUTER
- RT-1720/TSQ-158 EPUU
- GPS Interface Unit (GPSIU)

USS Nassau

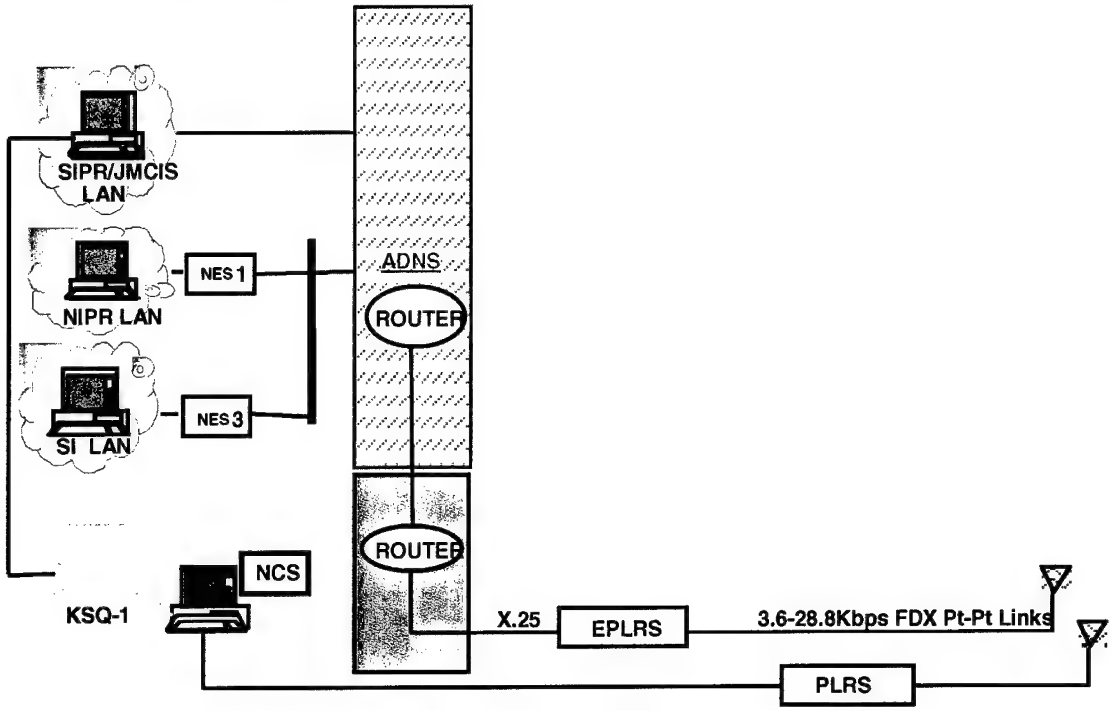

Figure 2-3. USS *Nassau* PLRS/EPLRS block diagram.

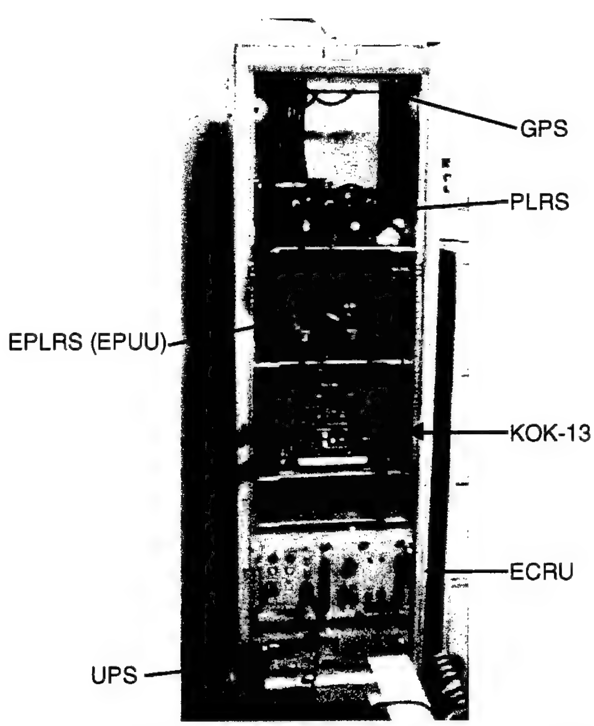

Figure 2-4. USS Nassau PLRS/EPLRS blcok configuration.

USS Nashville

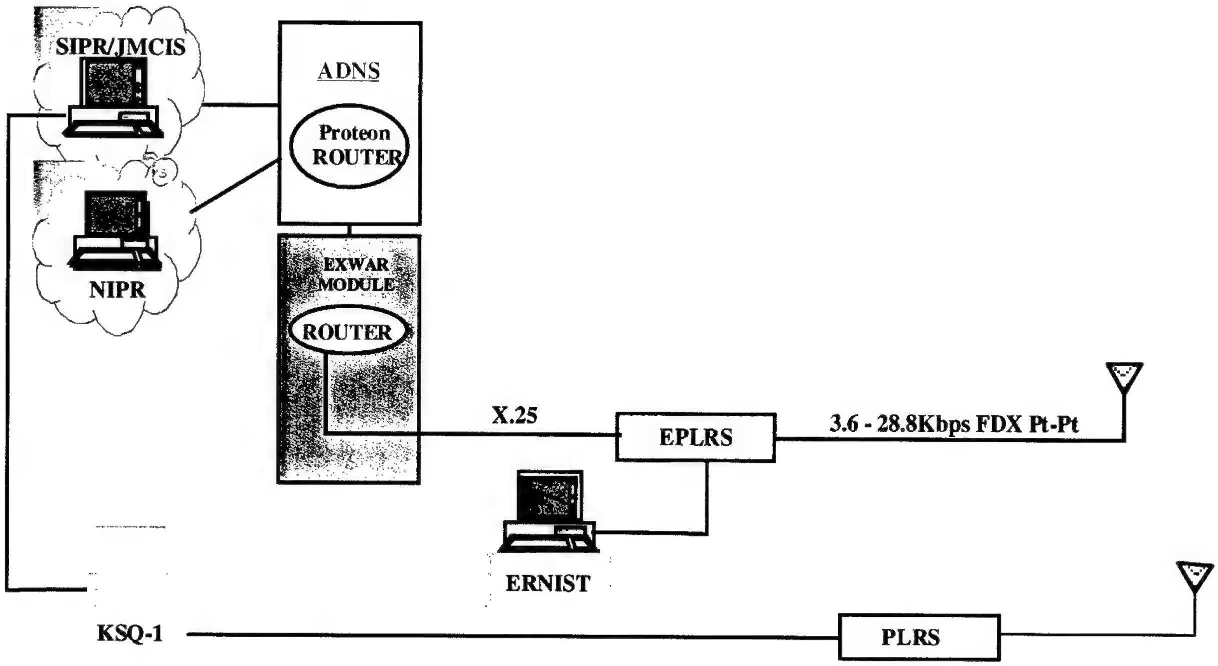

Figure 2-5. USS *Nashville* PLRS/EPLRS block diagram.

Shore Node

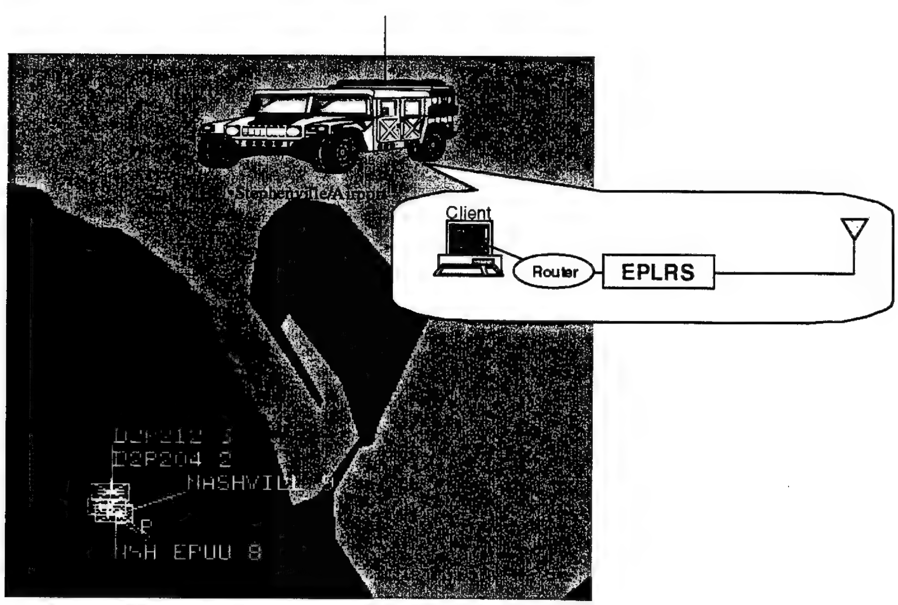

Figure 2-6. Transportable System EPLRS block diagram.

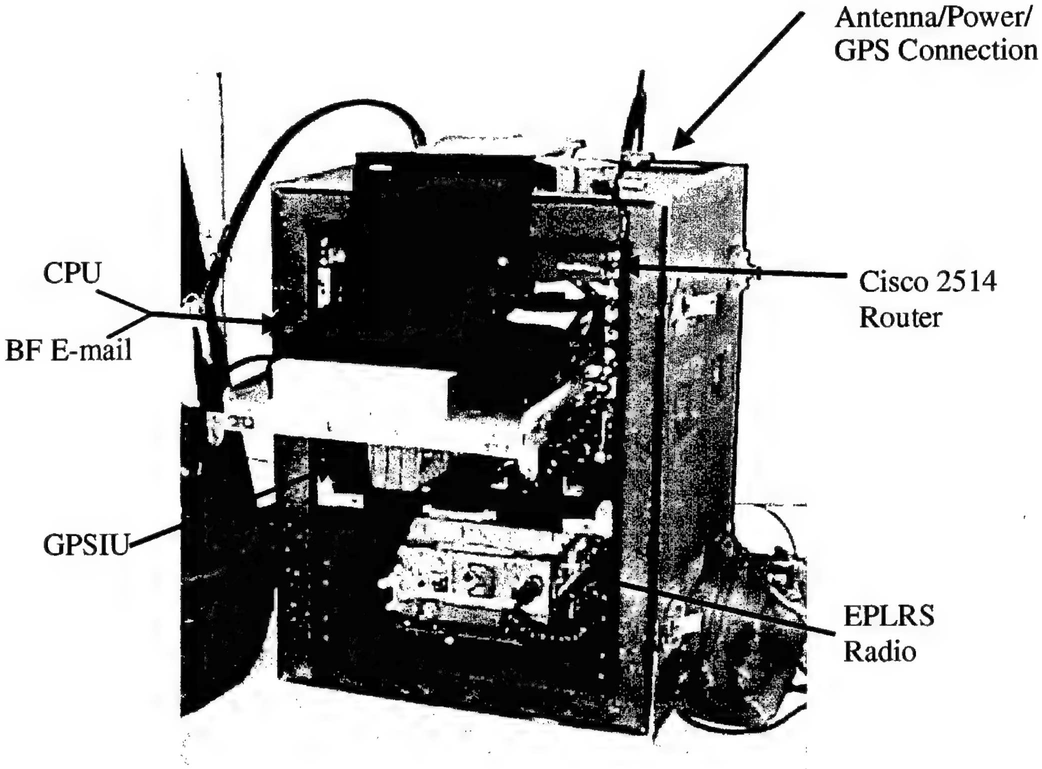

Figure 2-7. Transportable System configuration.

2.2.3 PLRS/EPLRS/AN/KSQ-1 System Equipment Distribution

Table 2-2 shows the installed quantities of the EPLRS downsized NCS, AN/KSQ-1, Enhanced PLRS User Unit (EPUU), PLRS Basic User Unit (BUU), and GPS receivers for each ship and craft, that participated in the demonstration.

Table 2-2. Equipment distribution.

Ship/Craft (Numbers)	NCS	AN/KSQ-1	EPUU	BUU	GPS
USS *NASSAU*	1	1 (ACS)	1	1	1
USS *NASHVILLE*		1 (PCS)	1	1	1
USS *PENSACOLA*					
USS *GUNSTON HALL*				1	
MARINE1 (Transportable)			1		1
MARINE2 (Transportable)			1		1
AAV (28)				26	2
LCAC (7)		7 (UTG)		7	7
LAV (12)					
LCU (4)					
Aircraft (7)					

2.2.4 Communication Needline Configuration

EPLRS point-to-point radio connections, or needlines, were established from ship-to-ship and ship-to-objective area as depicted in figure 2-8 and table 2-3. Overviews of unit needline connectivity and associated data transmission rates between shore and ship units are also shown.

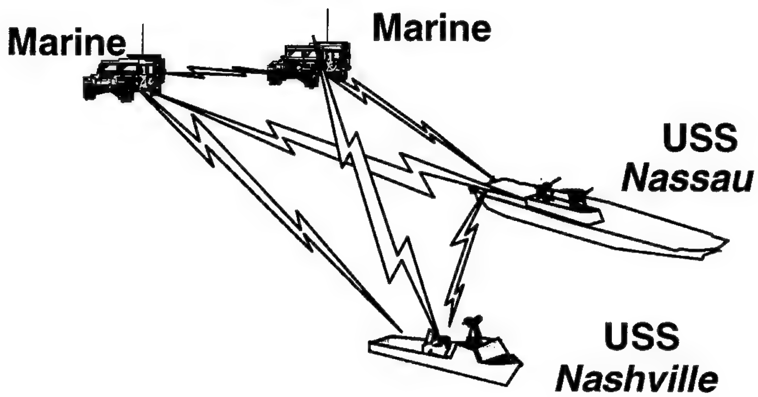

Figure 2-8. EPLRS data communications topology.

Table 2-3. Overview of unit needlines.

Needline Configuration	USS *NASSAU*	USS *NASHVILLE*	MARINE1	MARINE2
USS *NASSAU*		7.2, 28.8	3.6	3.6, 7.2
USS *NASHVILLE*	7.2, 28.8[1]		3.6	3.6
MARINE1	3.6	3.6		3.6
MARINE2	3.6, 7.2[2]	3.6	3.6	

1 Increased the data rate between USS *Nassau* and USS *Nashville* from 14.4Kbps (7.2 full duplex) with PLI to 56k (28.8 full duplex) with no PLI.

2 Increased the data rate between USS *Nassau* and USS *Nashville* from 7.2Kbps (3.6 full duplex) with PLI to 14.4Kbps (7.2 full duplex) with no PLI

3.0 TEST AND EVALUATION

3.1 LABORATORY TEST

The first task was to identify and baseline the EPLRS radio data connectivity capabilities. Since the use of this radio for TCP/IP connectivity was relatively new at the time, there was limited operational data on its HDR needline performance and throughput in a TCP/IP network environment.

Results showed that EPLRS supports FDX data rates from 3.6 to 28.8 Kbps, depending on the operational deployment of radios, PLI requirements, and TCP/IP applications supported. The SMTP e-mail message exchange format was chosen for the laboratory tests. The test setup consisted of five systems. Each system was composed of a POP3 e-mail client and a SMTP server that was connected to a Cisco 2514 router via its Ethernet interface. The Cisco router serial interface was connected to the EPLRS X.25 radio interface. The EPLRS radios were controlled by an NCS. The Cisco 2514 routers provided the Ethernet-to-X.25 conversion necessary to interface an Ethernet Local Area Network (LAN) to the EPLRS radio. The actual measured point-to-point throughput was nominally lower than the advertised data rate, but the robustness and reliability of the radio more than compensated for this. Throughput measurements were made by timing e-mail exchanges between units and by the use of the EtherPeek network-sampling device. Listed below are the average measured throughputs for the combination of one transmit and one receive needline:

a. 3.6 Kbps needlines: 3.4 Kbps average

b. 7.2 Kbps needlines: 6.9 Kbps average

c. 14.4 Kbps needlines: 14.1 Kbps average

d. 28.8 Kbps needlines: 28.4 Kbps average

Due to the requirements of the X.25 protocol-addressing scheme, the point-to-point EPLRS operating mode was the one identified as the best-suited for TCP/IP transfers. Specific X.25 protocol timer configuration details were identified and modified to optimize router connectivity. This information also identified the multi-point OSPF routing requirements in support of the dynamic routing functions provided by the ADNS interface. NCS and ERNIST needline library creation and their network management control functions were also tested in support of a TCP/IP network.

3.2 MARCOT TEST

The MARCOT exercise test was conducted onboard USS *Nassau* ARG during 8–19 June 1998, encompassing data collected from two afloat platforms and one mobile station. As in the laboratory tests, the forcing functions used to stimulate the system were e-mail messages injected opportunistically by test personnel onboard the ship and ashore. The EtherPeek network traffic sampling device was used as a data probe onboard USS *Nassau*.

3.2.1 Background

The basic research plan, published in December 1996, continues to be the guide for the EXCOM test series. This plan sets forth evaluation criteria and their measurements, data collection and analysis methods, and the test design used for all experiments. Literature substantiating the analysis methodology was referenced in USS *Boxer* EXCOM Report.

3.2.2 Test Procedures

Testing with the EPLRS radios onboard USS *Nassau* ARG was unique in the EXCOM test series in that it offered the first opportunity to evaluate message data exchange based on accurate position logs. This unique testing opportunity depended on the capture of reliable information on the relative positions of the participating platforms. It was facilitated by the presence of test personnel aboard USS *Nassau*, USS *Nashville,* and ashore.

In a previous test effort, the USS *Boxer* Deployment Test, the location of the platform was estimated using reconstructed PLRS/Joint Operational Tactical System (JOTS) data. During the MARCOT test period, members of the test team kept a log in which they recorded the relative positions of the participating platforms three times each day. To enhance the understanding of the parameters of the newly emerging virtual LANs, the EtherPeek network-sampling tool was installed between the BFEM system and the EPLRS Cisco 2514 router onboard USS *Nassau*. This probe recorded all packets on the LAN segment so that, upon recovery, its historical log could be analyzed as an adjunct to the compilation of message statistics.

3.2.3 EPLRS Network Topology

Figure 3-1 shows the EPLRS LAN topology. The EtherPeek network sampling software program, installed on a laptop personal computer (PC), was connected between USS *Nassau*'s BFEM system server's Ethernet port and the Cisco 2514 router's Ethernet 0 (e0) port, as shown in figure 3-1. The EtherPeek data probe connection was done over an Ethernet coaxial cable. The EtherPeek laptop PC clock and date were set to coincide with the date and time entered in USS *Nassau*'s BFEM SMTP server. The EtherPeek application was configured to intercept and record the first 64 bits of every packet present in that segment of the EPLRS LAN. Client and server PCs onboard all participating platforms were synchronized prior to sailing so that all PCs involved in the experiment had clocks set to the same local standard time. The analysis strategy was dependent on this reference time and required the recovery of records from the various BFEM POP3 e-mail clients' mailbox files and the servers' Network Operating System (NOS) log files.

The EPLRS network onboard USS *Nassau* and USS *Nashville* had a dedicated Ethernet LAN composed of one BFEM SMTP/POP3 server and one Eudora e-mail application client hosted on separate PCs. The third ship of USS *Nassau* ARG, the USS *Pensacola*, had no EPLRS equipment installed onboard during the MARCOT exercise, so it did not participate. Additionally, one transportable system—composed of an EPLRS radio, a Cisco 2514 router, and one combined BFEM client/server application hosted on a laptop PC—was established in consonance with the timing constraints of the operational scenario for the ground exercise. A second transportable system was established ashore late in the exercise, but it provided no meaningful data for analysis.

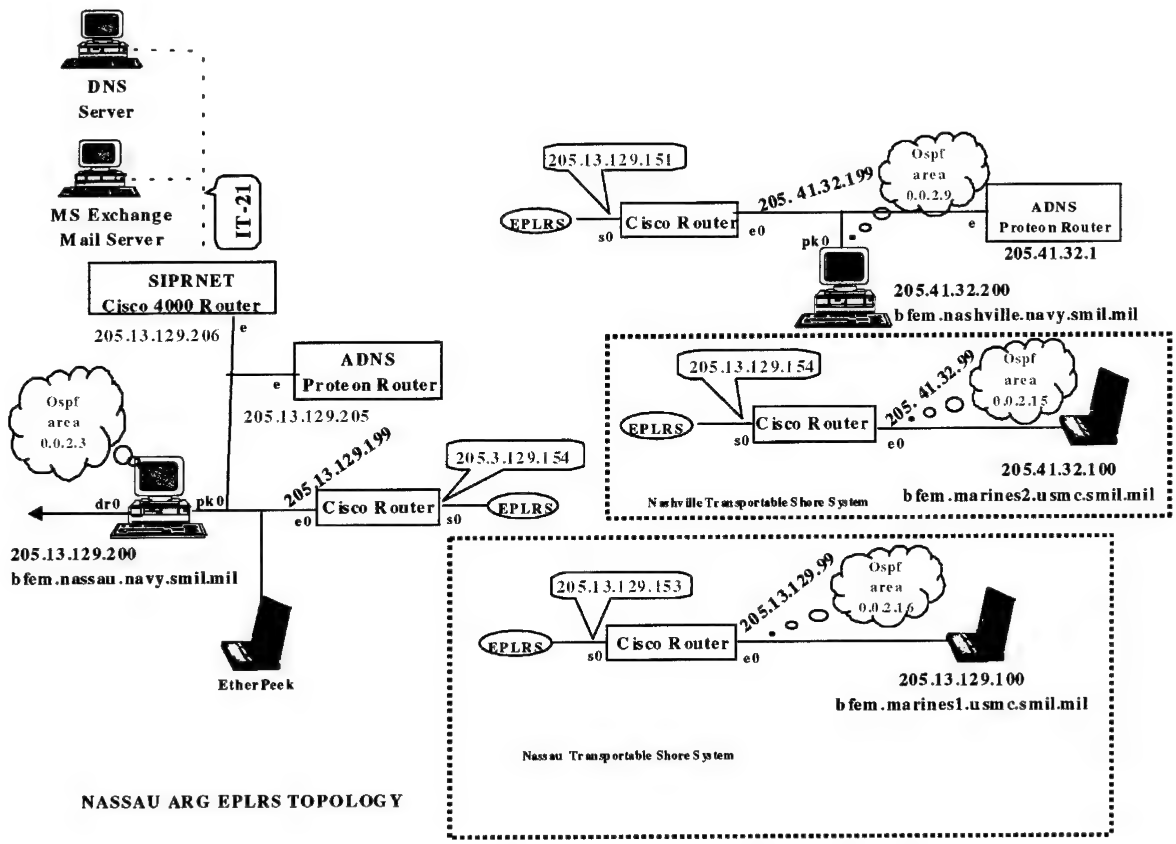

Figure 3-1. EPLRS network IP topology.

Test personnel were placed onboard USS *Nassau* and USS *Nashville* to observe and maintain the operation of the EPLRS radio system. Ship personnel were unfamiliar with this system. As a collateral duty, this staff was tasked to monitor the operation of the network test equipment and to provide test simulation messages by using the network as a control net for the operation of EPLRS. Additionally, a small number of operational end-users onboard USS *Nassau* and USS *Nashville* were permitted to use the EPLRS network as a matter of convenience. The messages injected by these end-users were filtered out in the post-experiment data-reduction process since their content and correspondent addresses could not be verified.

3.2.4 Analysis

Analysis of the data collected during the FY 1998 USS *Nassau* ARG MARCOT exercise operations is discussed for message data files and packet data from the network sampling tool. Six hundred and seventy six messages were transmitted among the two stations afloat and the one ashore. These were received and distributed as shown in table 3-1. No transmission failures were experienced.

Table 3-1. Incoming e-mail distribution.

FromTo	USS *NASSAU*	USS *NASHVILLE*	Marines 2	Total
USS *NASSAU*		264	49	313
MARINE2	65	20		85
USS *NASHVILLE*	264		14	278
			TOTAL	676

3.2.5 Data Recovery

The BFEM NOS server log files were copied to a separate file on each platform for each day of the demonstration. The Eudora incoming message In.mbx and Out.mbx files of each e-mail client PC was copied to a disk. The EtherPeek laptop and test data collector's position logbooks were returned to the test director at the conclusion of the demonstration.

3.2.6 Analysis Introduction

USS *Nassau* acted as the network control station for the EPLRS virtual LAN segment examined during this experiment. The EtherPeek network sampling device was installed between the BFEM SMTP/POP server (IP address 205.0.129.200) and the Cisco 2514 router (IP address 205.0.129.199). The Cisco 2514 serial 0 (s0) port was then connected to the X.25 port of the EPLRS radio. The Ethernet LAN servicing the EPLRS radio server/client nodes also served the UHF LOS MDR system and the ADNS Secure Internet Protocol Router Network (SIPRNET) node.

3.2.7 MARCOT EPLRS/ADNS Interconnectivity

A network topology issue became evident early in the demonstration planning phase, presenting a problem for data collection efforts planned for the MARCOT exercise. The EXCOM effort's focus was to collect data relevant to the EPLRS network behavior and performance. Although ADNS interconnectivity to EPLRS was an important part of the 1998 effort, its intrinsic behavior posed a threat to the data collection effort. First, ADNS features dynamic IP routing through its use of the OSPF routing protocol. OSPF heightens ADNS efficiency by allowing the system to choose the fastest path before selecting another, possibly slower, route.

In addition to EPLRS, the UHF LOS MDR wideband system was operational during the MARCOT exercise and provided 448 Kbps connectivity between ships. Since the UHF LOS MDR system was potentially going to provide a faster connection than EPLRS, as long as both RF paths were polled by ADNS, the faster one would always have been chosen over the other. Thus, ADNS was going to choose the fastest path between the two, and the risk of being unable to exercise the EPLRS path and collect data became high.

Since EPLRS interfacing into ADNS had already been demonstrated in the laboratory and ship-to-ship pierside tests, the decision was made to isolate the EPLRS network from ADNS during the

exercise to maximize data collection. The EPLRS radios were reconnected to ADNS after the exercise was over and the USS *Nassau* ARG deployed with EPLRS fully interfaced to ADNS.

The EPLRS network was isolated from ADNS during MARCOT by using static routing procedures. The BFEM NOS provided IP pointers, which allowed the BFEM server to pass traffic directly to the EPLRS Cisco 2514 router for transmission over the network. This allowed the test team members to control the dissemination of messages and data collection, which would have been very difficult to achieve if ADNS had been making the routing decisions. The EPLRS topology implemented during the MARCOT experiment rendered USS *Nassau*, USS Nashville, and transportable EPLRS systems as a stand-alone network.

3.2.8 Message Data Analysis

Message data were reduced and treated according to the standard practice of the EXCOM test series. Data from the raw log files were stripped and prepared as described in the data conditioning sections of the procedure documentation. The data were then organized into time-ordered bins of 24-hour duration as a precursor to histogram construction. (See table 3-2.) The grouped packet data were then analyzed.

Table 3-2. Bin-grouped messages.

Bin	No.	Bin	No.	Bin	No.
6/7/9820:00	0	6/0/98 8:00	0	6/18/9 16:00	19
6/7/9824:00	2	6/0/98 12:00	2	6/18/98 20:00	19
6/8/98 4:00	15	6/0/98 16:00	6	6/18/98 24:00	6
6/8/98 8:00	0	6/0/98 20:00	7	6/19/98 4:00	5
6/8/9812:00	23	6/0/98 24:00	4	6/19/98 8:00	0
6/8/9816:00	11	6/14/98 4:00	1	6/19/98 12:00	6
6/8/9820:00	5	6/14/98 8:00	0	6/19/98 16:00	5
6/8/9824:00	17	6/14/9812:00	0	6/19/98 20:00	5
6/9/98 4:00	8	6/9/98 4:00	8	6/19/98 24:00	0

On the average, the network carried 52 messages per day during the 13 days of this exercise. As table 3-1 shows, of the 676 messages exchanged during the exercise, USS *Nashville* received 278, and the mobile transportable system (MARINE2) received 85. In general, the distribution of these messages over the time of the exercise was consistent with the opportunistic communications needs of the EPLRS circuit management operations. Figure 3-2 shows the distribution of incoming messages to the server onboard USS *Nassau*.

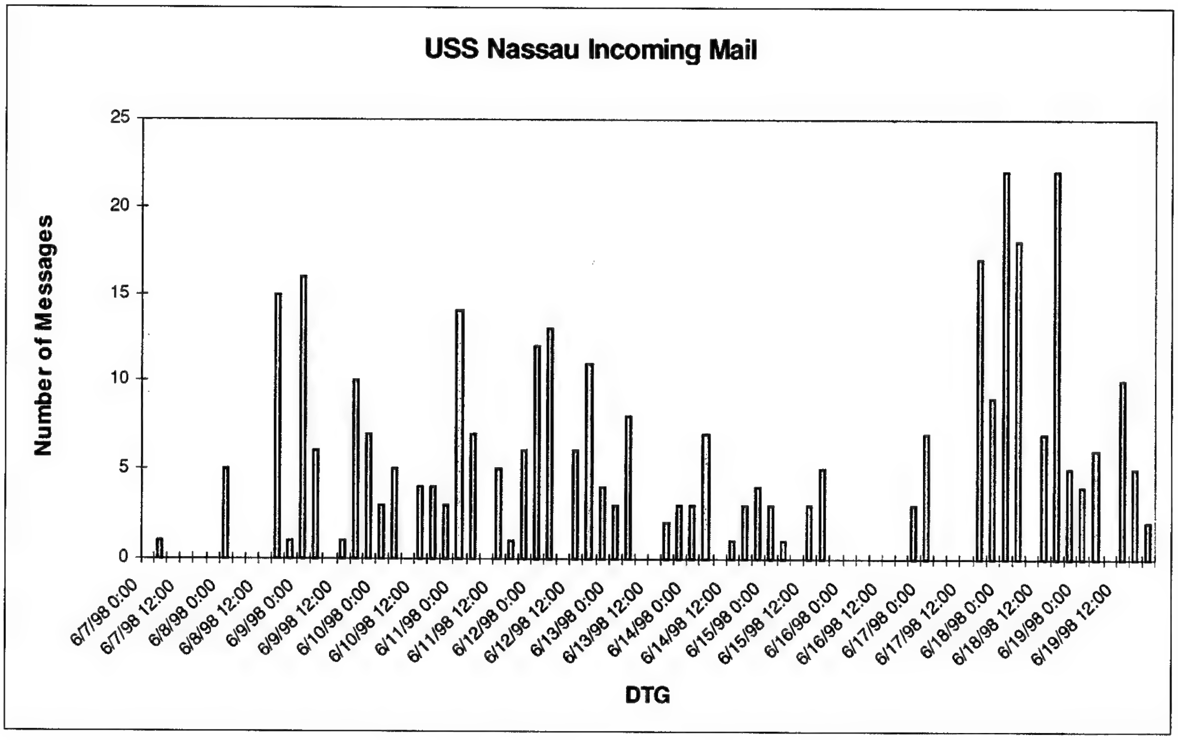

Figure 3-2. USS *Nassau* incoming e-mail.

Over the 2 days during which it was operational, the MARINE2 transportable system received 63 messages, which were distributed as shown in figure 3-3. The origins of these messages were from USS *Nassau* and USS *Nashville*, which were then operating approximately 7.5 miles from the shore (refer to table 3-3).

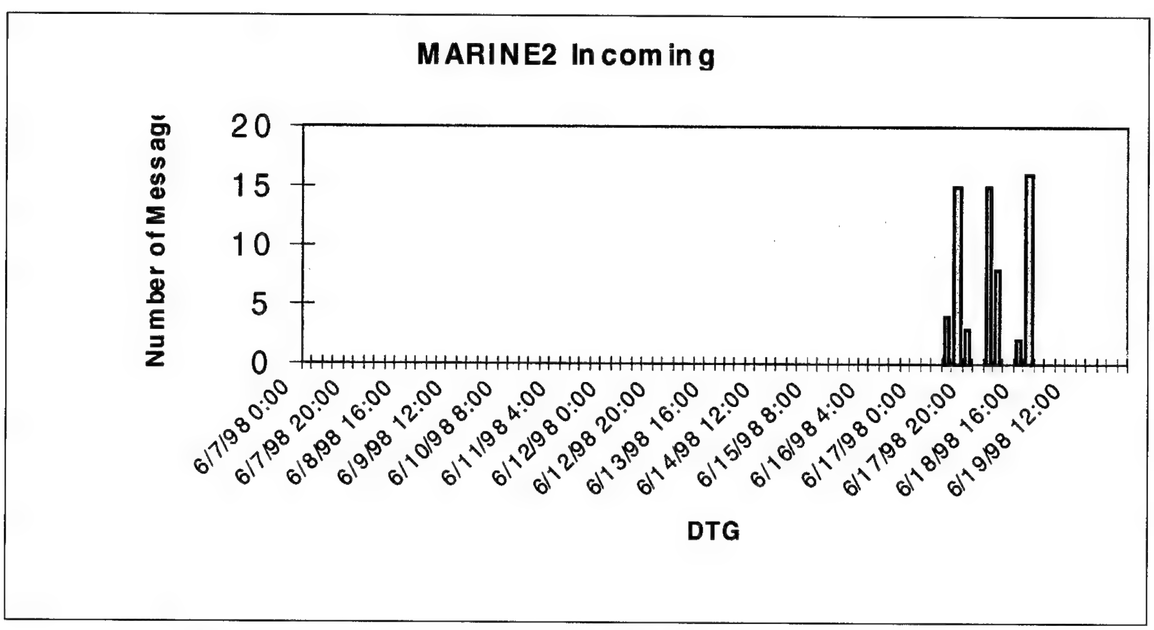

Figure 3-3. Transportable System (Marine2) incoming e-mail.

Table 3-3. Range and bearing from USS *Nassau.*

Date	Range (nmi)	Bearing True (degrees)	Range (nmi)	Bearing True (degrees)
6/15/98 12:00	3.56	38	7.89	49
6/15/98 16:00	3.68	39	7.89	44
6/15/98 20:00	3.88	40	7.75	43
6/16/98 8:00	3.63	43	7.75	43
6/16/98 12:00	3.63	43	7.75	43
6/16/98 16:00	3.63	43	7.75	43
6/16/98 20:00	3.63	43	7.75	43
6/17/98 8:00	3.63	43	7.75	43
6/17/98 12:00	3.63	43	7.75	43
6/17/98 16:00	3.91	0	7.70	42.6

The frequency of the messages received by USS *Nashville* (shown in the histogram of figure 3-4) exhibits a distribution not unlike that of the USS *Nassau*. EPLRS TCP/IP data connectivity was achieved at up to a distance of 40 nautical miles between USS *Nassau* and USS *Nashville* over 7.2 Kbps FDX needlines. The maximum needline data rate tested between the ships was 28.8 Kbps FDX at a distance of approximately 25 nautical miles. The maximum EPLRS needline data rate connection to the MARINE2 transportable system was 7.2 Kbps FDX at a distance of approximately 8 nautical miles.

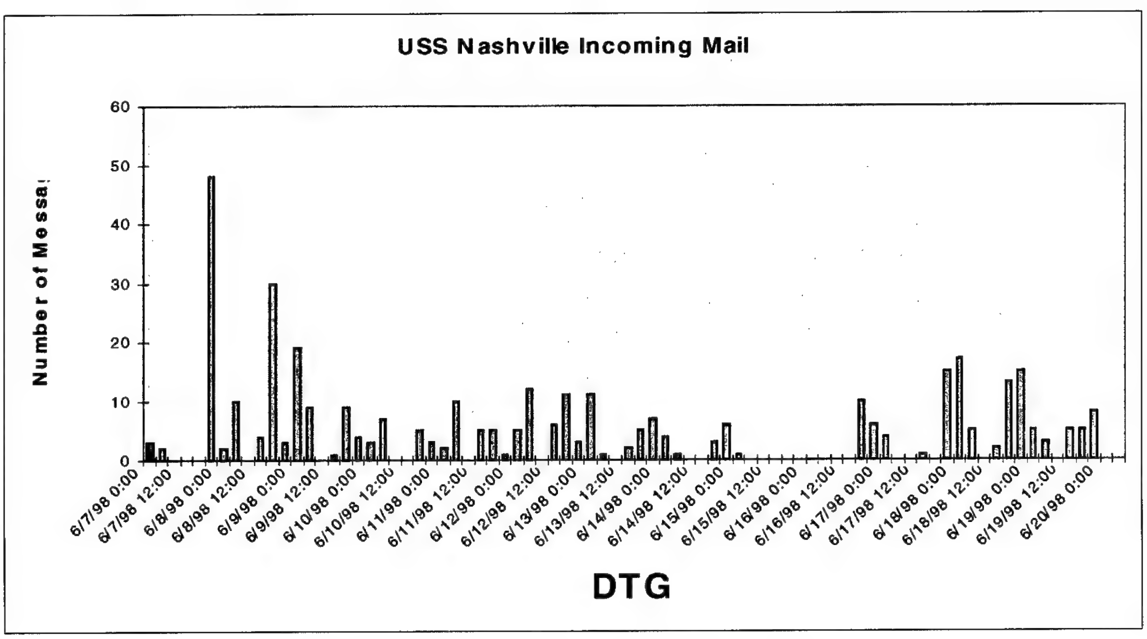

Figure 3-4. USS *Nashville* incoming mail.

3.2.9 LAN Sampling Data Analysis

The EtherPeek LAN data-sampling tool installed on USS *Nassau* intercepted and recorded the first 64 bits of every data packet transmitted on the Ethernet LAN during the period of 7–14 June 1998. Upon its recovery, the files were examined and the packets were organized to segregate the transport layer TCP/IP data communications among the nodes of interest. The packets were then grouped into 24-hour segments, and were reviewed for credibility vis-à-vis the exclusion of the ADNS and UHF LOS MDR link data packets. This was accomplished by ensuring that all of the data under review were exclusively TCP/IP packets taken from router IP addresses 205.13.129.150 and 205.13.129.151.

The entire set of daily files was then joined and subjected to a final source screening based on the Ethernet addresses of the physical layer. Once it was ensured that no spurious packets had been included, these aggregated packet files were analyzed with the tools embedded in the EtherPeek application.

Figure 3-5 is a graphical representation of the flow of packets from USS *Nassau* to USS *Nashville* on 12 June 1998. This example of packet analysis was prepared as a function of the EtherPeek software diagnostic capability, produced from the recorded data for 12 June 1998 after filters had been set so that all non-TCP/IP packets were discounted. It shows that there was no e-mail traffic leaking through the router barriers and that there was no extraneous SMTP traffic on the EPLRS network.

Figure 3-5 also shows that there were 15,942 packets in the database for 12 June 1998, which matched the conditions set by the filters. It also indicates that these packets represent 100 percent of the network load under the prescribed transport protocol. The analysis of EPLRS communications was performed by applying the embedded EtherPeek tools to the aggregated packet data for Period 2.

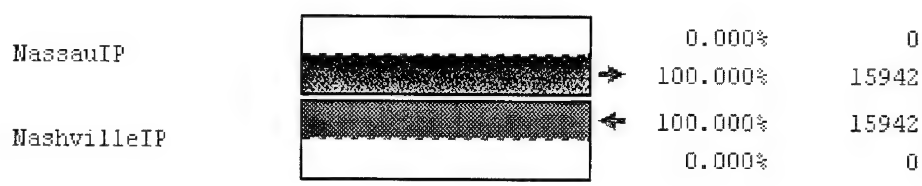

Figure 3-5. Flow of TCP/IP packet data from USS *Nassau* to USS *Nashville* (12 June 1998).

Figure 3-6 shows the resultant analysis panel for packet data aggregated from the files of 7–14 June 1998. During this period, there were 23,553 packets of TCP/IP message traffic transmitted from USS *Nassau* to USS *Nashville*. The average packet size was 113 bits. The MARINE2 transportable system did not come online until 17 June. The total number of packets transmitted during the entire MARCOT period was much higher than the one shown in figure 3-6, but an EtherPeek Laptop failure on 15 June 1998 kept measurements from being taken after that date.

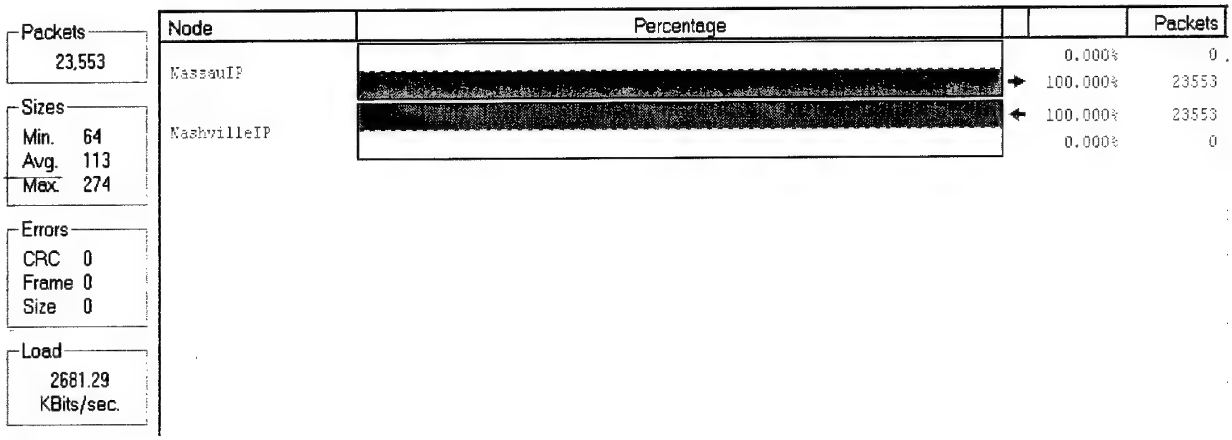

Figure 3-6. Output distribution, USS Nassau (8–14 June 1998).

3.3 POSITION LOCATION INFORMATION

3.3.1 Background

Real-time NCS processing of track data provides the basis for up-to-date display of all units equipped with PLRS and EPLRS radio sets (RS). Track data quality is determined by the NCS based on the signal strength received from a radio. An RS can be in direct LOS to the NCS or it can relay via another RS. When using a relaying radio, the signal strength of the relaying RS will affect the track quality of the originating radio, as the NCS can only report track quality based on the quality of reception from a directly connected RS. Therefore, if the relaying radio has poor signal strength, the originating RS will be shown to have a poor track quality, regardless of its signal strength to the relaying radio.

3.3.2 PLI During MARCOT

PLRS and EPLRS track quality during the MARCOT exercise varied from situation to situation. If the ships moved beyond LOS from USS *Nassau*, the NCS would show no updated track quality for those units. When the ships moved into a straight-line formation, they had an average track quality of 4.9 on a scale of 1 to 10.

This can be compared to a track quality of 8.0 when all the ships were dispersed in a triangular formation and within LOS. When ships steamed in a straight-line formation and good geometry was not possible, PLI had to be obtained via GPS. PLRS and EPLRS PLI dissemination requires triangulation of reference points.

A maximum of 28 RSs was tracked during the amphibious assault on 16 June 1998, with an average track quality of 6. Landing Craft Air Cushions (LCAC) were tracked all the way to the beach and back. Amphibious Assault Vehicles (AAVs) were tracked to the beach, on the beach and beyond, and back to their ships, as shown in figures 3-7 through 3-9.

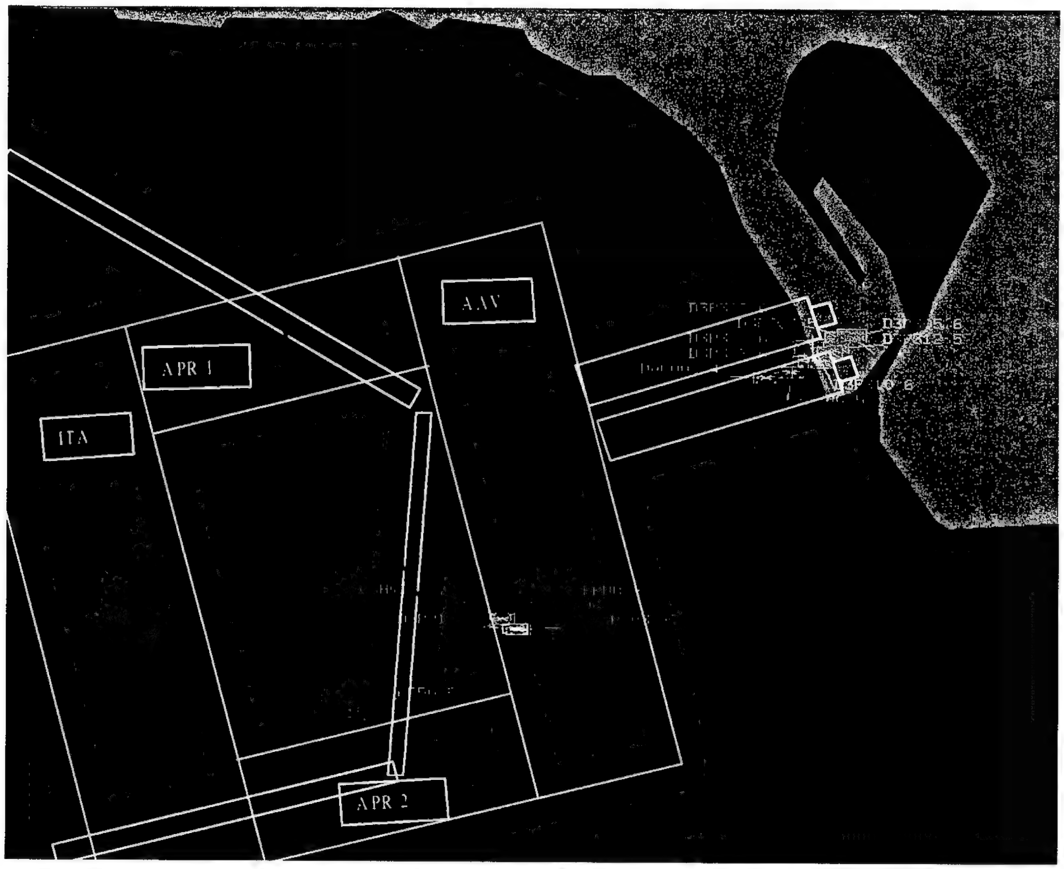

Figure 3-7. First wave of AAV hitting the beach during MARCOT/UNIFIED SPIRIT 98.

A line drawing of the operations area ashore was entered at the NCS to reflect the salient features of the paper maps in use, which were developed using the North American 27 datum. Maps displayed by JMCIS and other command and control systems were based on the World Geodetic Survey 1984 (WGS-84) datum, which resulted in a position difference. The 100,000-meter grid square designators were incorrect and an error of 60 meters occurred in Easting and 220 meters in Northing values.

The NCS PLI tracks onboard USS *Nassau* were highly accurate and obtained in near real time. The tactical officers at the Landing Force Operations Center (LFOC) were constantly checking with the NCS and KSQ-1 operators to ascertain position updates for the various units and amphibious craft. This prompted the MEF G-3 Air Officer to request the NCS to be connected directly into the LFOC TCO. The NCS display was patched directly into the large screen display in the LFOC. This gave the large screen display the exact picture that displayed on the NCS operator's display.

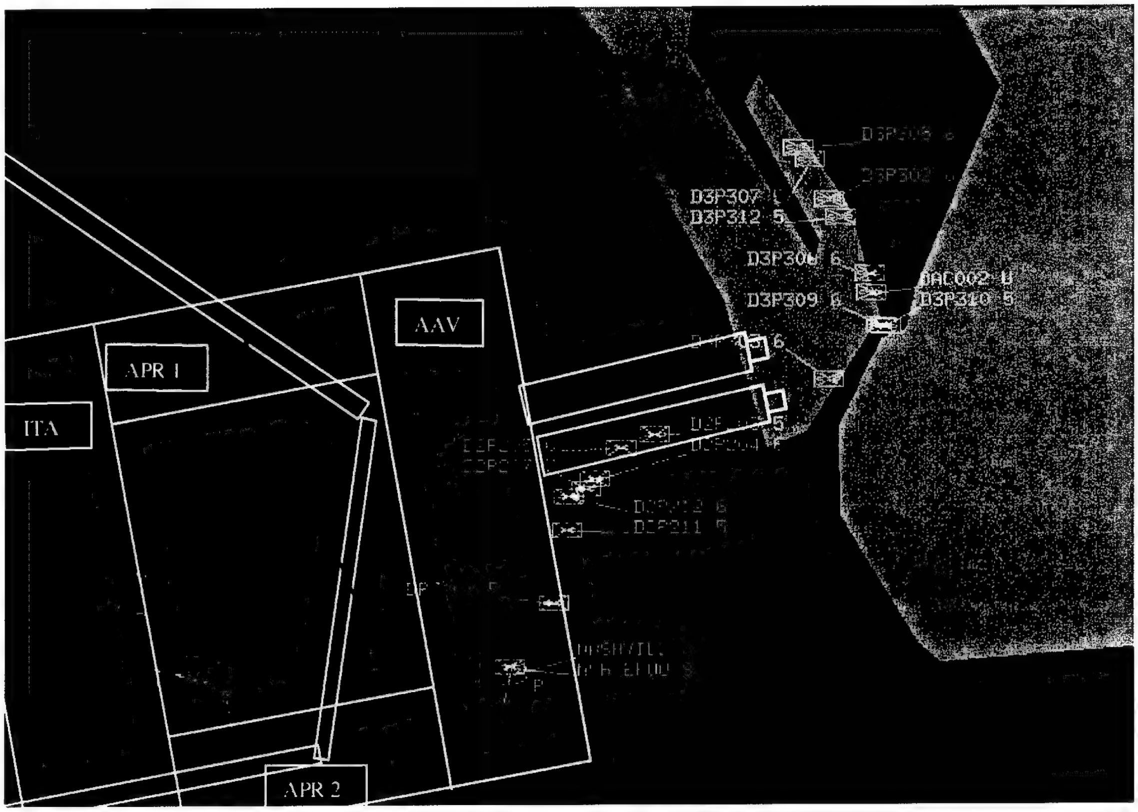

Figure 3-8. First wave moving inland; second wave in the water.

3.3.3 USS *Nashville*

All terminals (KSQ-1, Joint Countermine Application (JCA), and JMCIS) onboard were configured to display the same overlays and colors to depict the CTP. Land masses were displayed in orange, oceans in black ships, LCACs as small, light-blue circles, and AAVs as green military tactical symbols. The overlay showing Areas of Responsibility (AOR) and lanes to be traversed through the minefields was shown in yellow.

The first LCACs started moving at approximately 0100 hours, in preparation for delivering their cargo to the designated beach. The Combat Information Center (CIC) personnel onboard USS *Nashville* viewed LCAC movements as they left their ships with embarked Light Armored Vehicles (LAVs), dropped them off at their designated beach sites, and returned to their ships. LAVs could not be tracked because they were not equipped with PLRS BUUs; the tactical picture would have been enhanced if the LAVs had mounted PLRS radios.

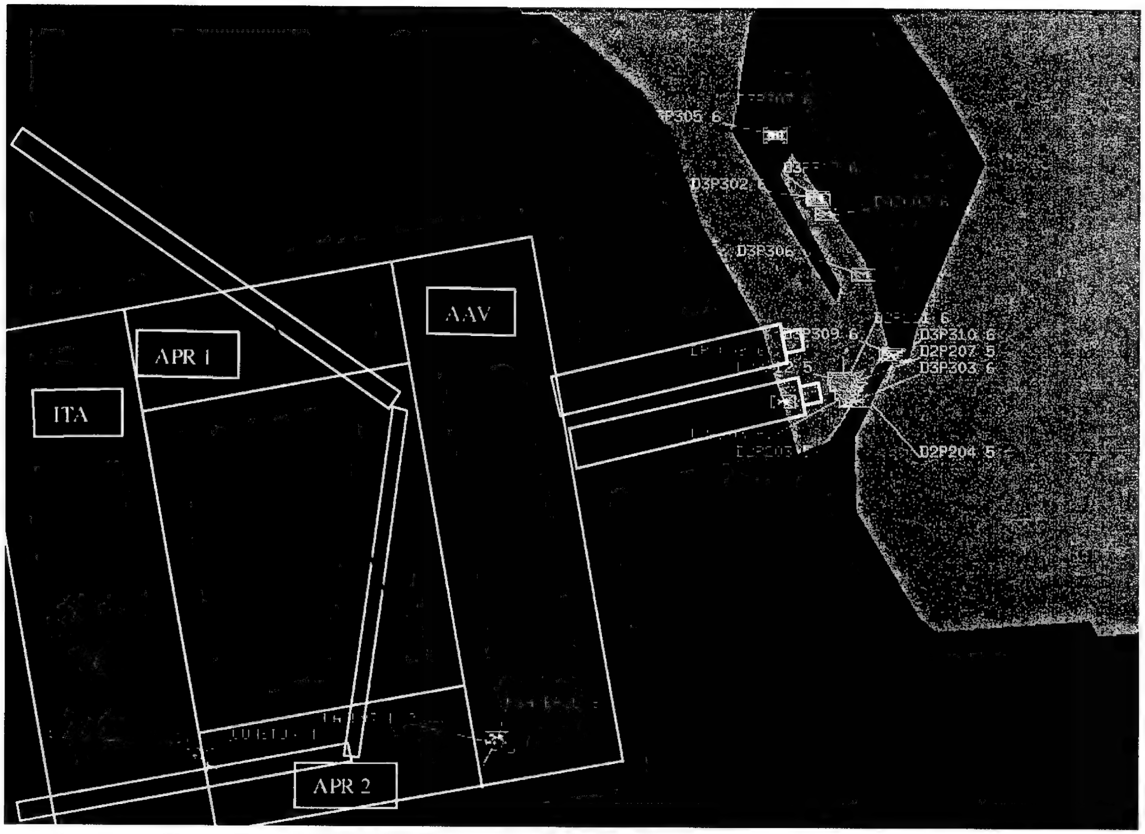

Figure 3-9. All AAVs moving inland.

Later that morning, CIC watched as the LCACs embarked the Clausen Power Blade remotely controlled mine clearance Novel System, used to clear the beach of any enemy mines as the Marines came ashore. Two LCACs had moved into the welldeck of USS *Pensacola*, waiting for orders to deliver their cargoes to the beach. CIC personnel watched their progress down the center of the lanes depicted on the overlay, through the minefields, and up onto the beach. The LCACs dropped off their cargo and returned to the water. Although two AAVs were in the water offshore working the remote controls for the Clausen Power Blade ashore, the two AAVs could not be tracked because they did not have PLRS BUUs onboard.

The terminal displays became very active as the first wave of AAVs started up in the welldeck of USS *Nashville* and entered the water. Of the 13 AAVs in the first wave, nine were up and operational on PLRS. CIC personnel watched as the AAVs traversed the guide lanes through the minefields in the water and on the beach, and then moved inland. The second wave followed the same path as the first, with the same number of AAVs and the same number of active PLRS units. Again, CIC watched as they traversed the guide lanes through the minefields and joined the first wave of AAVs.

4.0 OBSERVATIONS

A significant number of messages were exchanged during the laboratory and MARCOT exercise testing periods. During MARCOT, the distribution of transmissions (represented by the histograms of figures 3-2 through 3-4) confirms operators' reports of the network's general availability. No message transmission failures were recorded in any mail or server logs, nor did the Ethernet probe indicate any incomplete packet transfer. Although the actual data throughput was somewhat less than the maximum advertised needline throughput, EPLRS still had a favorable performance in comparison with standard shipboard HF, VHF, and UHF HDX LOS systems. The EPLRS needline data rate and distance performance were satisfactory over the course of the transit to the AOA and actual exercise.

The number of needlines operational at any given time from ship-to-ship and ship-to-shore ranged from one to a maximum of six, using four EPUUs. Needline rates varied between USS *Nassau* and USS *Nashville*, and between USS Nassau and the transportable systems, MARINE1 and MARINE2. Needline data rates between 3.6 and 28.8 Kbps were demonstrated.

It should be noted that it was not necessary to recycle the NCS to change EPUU needlines. For example, NCS needline library updates in conjunction with an EPUU reset enabled the NCS operator to increase needline rates from 7.2 to 28.8 Kbps between the USS *Nassau* and the USS *Nashville*.

E-mail communications via EPLRS were established ship-to-ship and ship-to-shore. Messages were configured both with and without attachments, receipt requests, and message forwarding. Message length varied from 1 to 500 kilobytes (Kbytes) while needline rates varied from 3.6 to 28.8 Kbps. User throughput was, on average, fairly close to the advertised maximum radio throughput. During some periods, there were instances of low throughput, which appeared to be caused by interference (air operations, atmospheric conditions, etc.), and message traffic load.

Figure 4-1 depicts a Marine using a transportable unit and shows a front view of the unit.

Presently, the Navy and Marine Corps are not actively deploying EPLRS. The Marine Corps has PLRS systems fielded throughout the Fleet Marine Force (FMF). The Navy has equipped amphibious assault ships (LHDs and LHAs) with PLRS MSs, and selected amphibious transport docks (LPDs) and dock landing ships (LSDs) with PLRS BUUs. In the case of the Navy, all PLRS installations are part of the AN/KSQ-1 AADS. Nevertheless, EPLRS is destined for both the Fleet and FMF. EPLRS EPUUs are currently planned as functional replacements for the PLRS BUUs (no longer manufactured) as part of further Navy AN/KSQ-1 installation efforts. Similarly, EPLRS EPUUs are slated to be fielded by the Marine Corps in a data-only role in the FY 1999–2000 time frame.

The true significance of the PLRS/EPLRS system demonstrated during the MARCOT exercise is that this effort represented a successful technical demonstration of a truly hybrid PLRS/EPLRS network that exploited the re-use of legacy equipment (i.e., PLRS). It introduced new and higher data rate communications capabilities via the EPLRS EPUU (3.6 to 28.8 Kbps TCP/IP versus 360 bits per second (bps) American Standard Code for Information Interchange (ASCII) with PLRS). It also exploited technological advancements of equipment downsizing through installation of the much smaller EPLRS NCS prototype on USS *Nassau* (equivalent to what is slated for installation on LHDs 6 and 7).

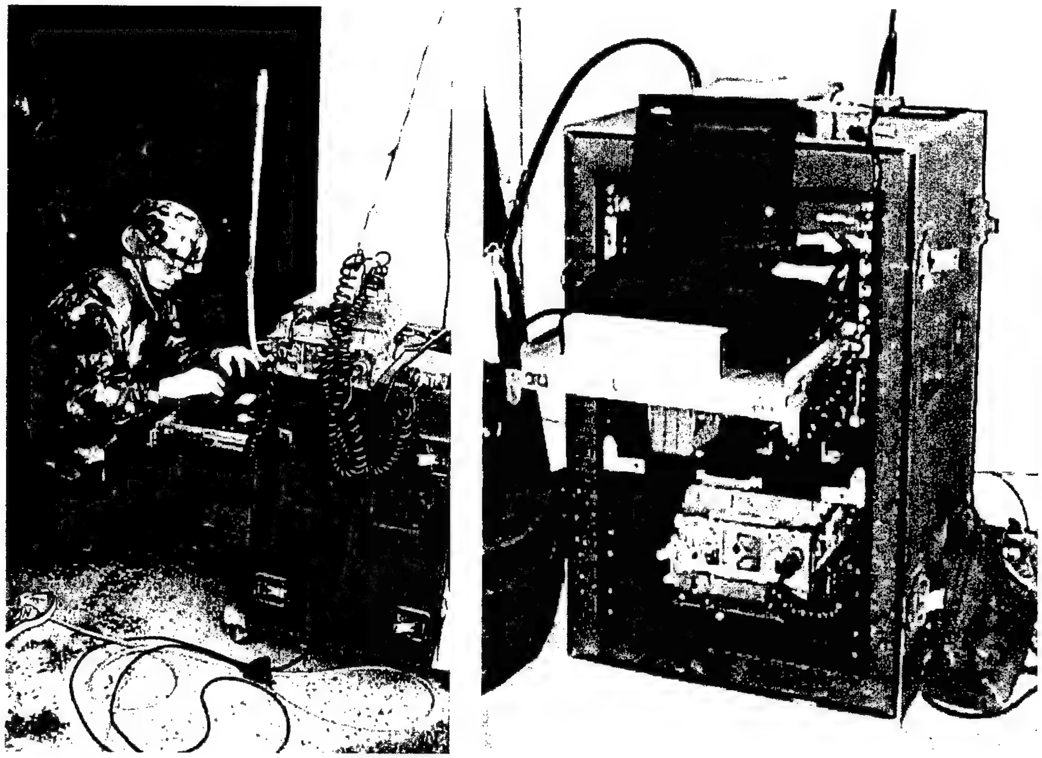

Figure 4-1. Transportable System Ashore.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 EPLRS CRYPTOGRAPHIC KEYING MATERIAL

The Army remains the only service with fielded EPLRS systems. As such, the Army EPLRS Program Office at Fort Monmouth remains the single controlling authority for both operational and test keying material (keymat). The use of test keymat is designated by the Army as appropriate for units being introduced to EPLRS equipment fielding. Their intent is to use test keymat for up to a year to allow the system configuration and implementation architecture to be fully understood before requesting a unit-specific, unique set of keymat. The test keymat used during the MARCOT exercise was authorized for transmission security of traffic up to the level required for the type of data transferred during the demonstration. At the Navy's request, the EPLRS Program Office authorized the release of test cryptographic keying material to cover the USS *Nassau* ARG's deployment. It is recommended that the Navy and Marine Corps establish the requirement and quantity of EPLRS keymat for testing and operational use. Once identified, the Director Cryptographic Material Service (DCMS) should be provided the information necessary to handle the dissemination.

PLRS and EPLRS keymat generation and dissemination is also viewed as an operational issue for ships at sea and for ship-to-shore transfers. First, the generation of the keymat requires the use of a KOK-13 crypto, which is not a common Navy asset. Secondly, the over-the-air keymat loading and advancement poses some operational challenges for ships afloat. As long as the ships involved remain in LOS of each other, the ship with the NCS can load and advance keys over the RF path via the EPLRS radios. Under this scenario, the network operation is not interrupted. If a ship moves beyond LOS, but comes back into LOS range of the ship with the NCS within the keymat period—and assuming that the keymat was not "zeroized"—then the ship coming back in LOS will re-enter the network and easily receive the keymat update. However, if a ship separates itself from the ship with the NCS for a period longer than the keymat operational expiration date, and it comes back in LOS after that date, then that radio would have to be physically re-loaded. This is of importance since normally only the ship with the NCS would have the KOK-13 required to generate the keys. This scenario also applies to EPLRS radios ashore.

5.2 EPLRS POWER OUTPUT

The EPLRS power output level varies depending on the power amplifier duty cycle. Power output is reduced and increased automatically depending on the radio's thermal condition. If the radio is keyed constantly, which would be the case under a heavy TCP/IP network traffic load, the radio output power will be reduced. Although there was no empirical data collected to substantiate any performance degradation, lower power output most likely had a negative effect on the distance at which the data connections could be reliably maintained. It is understood that work on improving the power amplifier duty cycle is already in progress.

5.3 ANTENNAS

The number of antennas required to support the NCS, PLRS, EPLRS, and AN/KSQ-1 operations onboard a ship is viewed as an installation issue. Shipboard antenna space is limited and is an important factor when considering how practical it is to support and install a system onboard. An antenna coupler might be a viable solution for this problem.

5.4 EPLRS X.25 DATA PORT

Since the present and foreseeable future Navy and Marine Corps LAN requirements are TCP/IP based, having a true Ethernet port available on the radio would remove the need to have an external router providing Ethernet to X.25 protocol conversions.

5.5 PLRS/EPLRS BAROMETRIC PRESSURE CONNECTION

To provide ship elevation to the PLRS and EPLRS radios, the ship's hull must be breached for shipboard installation. The attendant difficulties and costs incurred are viewed as counterproductive. The ship elevation will not vary much as the ship proceeds from destination to destination. Additionally, the hull breaching may affect the ship's chemical warfare integrity. A mechanism to provide the means to supply the elevation information into the NCS should be devised.

5.6 NCS OPERATOR TRAINING AND AVAILABILITY

During the execution of this year's effort, the availability of trained NCS operators for ARG deployment was seen as a significant issue for both the Navy and the Marine Corps. Staffing requirements should be identified, and personnel should be trained and made available for ship work-up cycles and deployment.

APPENDIX A
GLOSSARY

AADS	Amphibious Assault Direction System
AAV	Amphibious Assault Vehicle
ACS	Amphibious Command Ships
ACWS	Amphibious Command Workstation
ADNS	Automated Digital Networking System
ALE	Automatic Link Establishment
AOA	Amphibious Operations Area
AOR	Area of Responsibility
ARG	Amphibious Ready Group
ASCII	American Standard Code for Information Interchange
ATF	Amphibious Task Force
ATM	Asynchronous Transfer Mode
BFEM	Battle Force Electronic Mail
bps	Bits Per Second
BUU	Basic User Unit
C3	Command, Control, and Communications
CAP	Channel Access Protocols
CIC	Combat Information Center
COP	Common Operational Picture
COTS	Commercial Off-The-Shelf
CTP	Common Tactical Picture
DCMS	Director Cryptographic Material Service
ECRU	Enhanced Command Response Unit

E-mail	Electronic Mail
EPLRS	EXCOM Enhanced Position Location Reporting System
EPUU	Enhanced PLRS User Unit
ERNIST	EPLRS Rapid Network Initialization System
EXCOM	Expeditionary Warfare Communications Enhancement
FMF	Fleet Marine Force
FWD	Forward
FY	Fiscal Year
GOTS	Government Off-the-Shelf
GPS	Global Positioning System
GPSIU	GPS Interface Unit
HDR	High Data Rate
HF	High Frequency
In.mbx	Incoming message mailbox
INM	Integrated Network Manager
IP	Internet Protocol
ISDN	Integrated Services Digital Network
JCA	Joint Countermine Application
JIC	Joint Intelligence Center
JINC	Joint Internet Controller
JMCIS	Joint Maritime Command Information System
JMCOMS	Joint Maritime Communications System
JOTS	Joint Operational Tactical System

Kbps	Kilobits per second
Kbytes	kilobytes
Keymat	Keying material
LAN	Local Area Network
LAV	Light Armored Vehicle
LCAC	Landing Craft Air Cushion
LFOC	Landing Force Operations Center
LHA	Amphibious Assault Ship
LHD	Amphibious Assault Ship
LOS	Line of Sight
LPD	Amphibious Transport Dock
LSD	Dock Landing Ship
MARCOT	Maritime Combined Operations Test
MDR	Medium Data Rate
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MS	Master Station
NCS	Network Control Station
NDI	Non-Developmental Item
NES	Network Encryption System
NIPR	Non-Secure Internet Protocol Router
NOS	Network Operating System
OMFTS	Operational Maneuver From the Sea
OSPF	Open Shortest Path First
OTH	Over the Horizon
Out.mbx	Outgoing message mailbox

PCS	Primary Control Ships
PCWS	Primary Control Workstation
PC	Personal Computer
PLI	Position Location Information
PLRS	Position Location Reporting System
POP	Post Office Protocol
R&S	Routing and Switching
RF	Radio Frequency
RS	Radio Sets
SACC	Supporting Arms Coordination Center
SCS	Secondary Control Ships
SCWS	Secondary Control Workstation
SINCGARS	Single-Channel Ground/Air Radio System
SIPRNET	Secure Internet Protocol Router Network
SMTP	Simple Mail Transport Protocol
SPAWAR	Space and Naval Warfare Systems Command
SSC San Diego	SPAWAR Systems Center, San Diego
STOM	Ship-To-Objective Maneuver
TAC	Tactical Advanced Computer
TACLOG	Tactical Logistics
TCO	Tactical Combat Operations System
TCP/IP	Transfer Control Protocol/Internet Protocol
TDMA	Time Division Multiple Access
UHF	Ultra High Frequency
URO	User Readout
UTG	User Terminal Groups

UU	User Units
VHF	Very High Frequency
WGS	World Geodetic Survey

APPENDIX B
EPLRS CISCO 2514 ROUTER CONFIGURATIONS

This appendix contains USS *Nassau* ARG MARCOT exercise routing tables used during the testing period, 7–19 June 1998.

"Eplrsrtr1"

version 11.3

no service password-encryption

service udp-small-servers

service tcp-small-servers

ip host router1 205.13.129.150

ip host router2 205.13.129.151

ip host router3 205.13.129.152

ip host router4 205.13.129.153

ip host router5 205.13.129.154

interface Ethernet0

ip address 205.13.129.199 255.255.255.224

interface Ethernet1

no ip address

shutdown

interface Serial0

ip address 205.13.129.150 255.255.255.224

no ip mroute-cache

encapsulation x25

ip ospf network point-to-multipoint

x25 ltc 1000

x25 htc 1999

x25 t20 64

x25 t22 64

```
x25 pvc 214 ip 205.13.129.151 0 broadcast
x25 pvc 215 ip 205.13.129.152 0 broadcast
x25 pvc 216 ip 205.13.129.154 0 broadcast
x25 pvc 220 ip 205.13.129.153 0 broadcast
lapb T1 1500
lapb N1 1096
lapb N2 4
interface Serial1
no ip address
shutdown
router ospf 1
network 205.13.129.192 0.0.0.31 area 0.0.2.3
network 205.13.129.128 0.0.0.31 area 0
no ip classless
no logging console
line con 0
exec-timeout 0 0
line aux 0
transport input all
line vty 0 4
login
end
```

"Eplrsrtr2"

```
version 11.3
no service password-encryption
service udp-small-servers
service tcp-small-servers
ip host router1 205.13.129.150
```

```
ip host router2 205.13.129.151
ip host router3 205.13.129.152
ip host router4 205.13.129.153
ip host router5 205.13.129.154
interface Ethernet0
ip address 205.41.32.199 255.255.255.224
interface Ethernet1
no ip address
shutdown
interface Serial0
ip address 205.13.129.151 255.255.255.224
no ip mroute-cache
encapsulation x25
ip ospf network point-to-multipoint
x25 ltc 1000
x25 htc 1999
x25 t20 64
x25 t22 64
x25 pvc 213 ip 205.13.129.152 0 broadcast
x25 pvc 214 ip 205.13.129.150 0 broadcast
x25 pvc 217 ip 205.13.129.154 0 broadcast
x25 pvc 219 ip 205.13.129.153 0 broadcast
lapb T1 1500
lapb N1 1096
lapb N2 4
interface Serial1
no ip address
shutdown
router ospf 1
network 205.41.32.192 0.0.0.31 area 0.0.2.9
```

```
network 205.13.129.128 0.0.0.31 area 0
no ip classless
no logging console
line con 0
exec-timeout 0 0
line aux 0
transport input all
line vty 0 4
login
end
```

<u>"Eplrsrtr3"</u>

```
version 11.3
no service password-encryption
service udp-small-servers
service tcp-small-servers
ip host router1 205.13.129.150
ip host router2 205.13.129.151
ip host router3 205.13.129.152
ip host router4 205.13.129.153
ip host router5 205.13.129.154
interface Ethernet0
ip address 205.41.192.199 255.255.255.224
interface Ethernet1
no ip address
shutdown
interface Serial0
ip address 205.13.129.152 255.255.255.224
no ip mroute-cache
```

```
encapsulation x25
ip ospf network point-to-multipoint
x25 ltc 1000
x25 htc 1999
x25 t20 64
x25 t22 64
x25 pvc 213 ip 205.13.129.151 0 broadcast
x25 pvc 215 ip 205.13.129.150 0 broadcast
x25 pvc 218 ip 205.13.129.154 0 broadcast
x25 pvc 221 ip 205.13.129.153 0 broadcast
lapb T1 1500
lapb N1 1096
lapb N2 4
interface Serial1
no ip address
shutdown
router ospf 1
network 205.41.129.192 0.0.0.31 area 0.0.2.14
network 205.13.129.128 0.0.0.31 area 0
no ip classless
no logging console
line con 0
exec-timeout 0 0
line aux 0
transport input all
line vty 0 4
login
end
```

"Eplrsrtr4"

version 11.3

no service password-encryption

service udp-small-servers

service tcp-small-servers

ip host router1 205.13.129.150

ip host router2 205.13.129.151

ip host router3 205.13.129.152

ip host router4 205.13.129.153

ip host router5 205.13.129.154

interface Ethernet0

ip address 205.41.192.199 255.255.255.224

interface Ethernet1

no ip address

shutdown

interface Serial0

ip address 205.13.129.152 255.255.255.224

no ip mroute-cache

encapsulation x25

ip ospf network point-to-multipoint

x25 ltc 1000

x25 htc 1999

x25 t20 64

x25 t22 64

x25 pvc 213 ip 205.13.129.151 0 broadcast

x25 pvc 215 ip 205.13.129.150 0 broadcast

x25 pvc 218 ip 205.13.129.154 0 broadcast

x25 pvc 221 ip 205.13.129.153 0 broadcast

lapb T1 1500

```
lapb N1 1096
lapb N2 4
interface Serial1
no ip address
shutdown
router ospf 1
network 205.41.129.192 0.0.0.31 area 0.0.2.14
network 205.13.129.128 0.0.0.31 area 0
no ip classless
no logging console
line con 0
exec-timeout 0 0
line aux 0
transport input all
line vty 0 4
login
end
```

"Eplrsrtr5"

```
version 11.2
no service password-encryption
service udp-small-servers
service tcp-small-servers
ip host router1 205.13.129.150
ip host router2 205.13.129.151
ip host router3 205.13.129.152
ip host router4 205.13.129.153
ip host router5 205.13.129.154
```

```
interface Ethernet0
ip address 205.41.32.99 255.255.255.224
interface Ethernet1
no ip address
shutdown
interface Serial0
ip address 205.13.129.154 255.255.255.224
no ip mroute-cache
encapsulation x25
ip ospf network point-to-multipoint
x25 ltc 1000
x25 htc 1999
x25 t20 64
x25 t22 64
x25 pvc 216 ip 205.13.129.150 0 broadcast
x25 pvc 217 ip 205.13.129.151 0 broadcast
x25 pvc 218 ip 205.13.129.152 0 broadcast
x25 pvc 222 ip 205.13.129.153 0 broadcast
lapb T1 1500
lapb N1 1096
lapb N2 4
interface Serial1
no ip address
shutdown
router ospf 1
network 205.41.32.96 0.0.0.31 area 0.0.2.15
network 205.13.129.128 0.0.0.31 area 0
no ip classless
no logging console
line con 0
```

```
exec-timeout 0 0
line aux 0
transport input all
line vty 0 4
login
end
```

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